with the pressure supplied from the master cylinder **12**. Of course, although not illustrated in FIG. **10**, it is contemplated that the master cylinder **12** can be operatively connected to selectively supply pressurized hydraulic brake fluid to the power cylinders **210** and **212**, if desired. It is also contemplated that separate power supplies may by used to power the motors of the power cylinders **210** and **212** to provide an additional level of redundancy and safety to the brake system **350**. Of course redundant, independently powered, and cross-checking control modules may be utilized, to control the operation of the power cylinders **210** and **212**, and of the proportional control valves **51***a* and **51***b*. It is also contemplated that all four of the vehicle brakes **11***a*, *b*, *c*, and *d* could be supplied from a respective power cylinder similar to the power cylinder **210**. The backup source **6** could be connected to two or four of the vehicle brakes **11***a*, *b*, *c*, and *d*. A suitable fluid separator unit **54***a* is preferably provided between the power cylinder and the connection of the backup source **6** in communication with the vehicle brakes **11***a*, *b*, *c*, and *d*.

The principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A brake system comprising:

a normal source of pressurized hydraulic brake fluid;

a backup source of pressurized hydraulic brake fluid;

a vehicle brake which is operated by application of pressurized hydraulic brake fluid thereto;

a valve for selectively preventing the flow of hydraulic brake fluid between the backup source and said vehicle brake; and

a fluid separator unit for maintaining the integrity of said backup source of pressurized fluid and preventing intermixing of the hydraulic brake fluid of said normal source and the hydraulic brake fluid of said backup source and having a movable pressure boundary which enables, through movement thereof, said normal source of pressurized hydraulic brake fluid to selectively act upon said vehicle brake via a portion of said backup source when said valve is shut.

2. The brake system of claim **1**, further including a brake system brake demand detection arrangement comprising:

a manually operated master cylinder;

a fluid conduit in fluid communication with said master cylinder;

a pedal simulator in fluid communication with said master cylinder via said fluid conduit, said pedal simulator including a spring and a piston acting to compress said spring under the influence of pressurized hydraulic fluid from said master cylinder exceeding a first pressure;

a pressure transducer generating a signal representative of the pressure of said fluid flowing between said master cylinder and said pedal simulator; and

an expansion volume unit in fluid communication with said master cylinder and said pedal simulator via said fluid conduit, said expansion volume unit permitting fluid to flow from said master cylinder into said expansion volume unit when said fluid exceeds a second pressure less than said first pressure.

3. The brake system of claim **2** wherein said pedal simulator further includes a housing defining a bore having

a first end adapted to be connected in fluid communication with said backup source, said bore further having a second end, said piston being slidably disposed in said bore and having a first face and a second face, said spring engaging said second face of said piston and acting between said piston and a portion of said housing to urge said first face of said piston toward said first end of said bore, and a damping circuit hydraulically interposed between said first end of said bore and said backup source to present a first cross sectional flow area to fluid flowing from said backup source through said damping circuit into said housing, and presenting a second cross sectional flow area to fluid flowing from said housing through said damping circuit, the ratio of said second cross sectional flow area to said first cross sectional flow area being greater than unity.

4. The brake system of claim **3** wherein said ratio is less than 10:1.

5. The brake system of claim **4** wherein said ratio is in the range of 2:1 to 4:1.

6. The brake system of claim **3** further including a relief valve opening above a predetermined pressure to permit fluid flow through said relief valve from said brake system to said housing.

7. The brake system of claim **6** wherein said predetermined pressure is in the range of about 5 bar to about 30 bar.

8. The brake system of claim **3** further including a relief valve opening above a predetermined pressure to permit fluid flow through said relief valve from said brake system to said housing.

9. The brake system of claim **8** wherein said predetermined pressure is in the range of about 5 bar to about 30 bar.

10. The brake system of claim **2** wherein said fluid separator unit has a housing defining a cylinder bore and a piston slideably disposed therein, said piston having a first working face in fluid communication with said normal source and a second working face in fluid communication with said backup source, said first and second working faces having substantially similar areas.

11. The brake system of claim **2**, further including:

a brake pedal for operating said master cylinder;

a pedal travel sensor for generating a stroke signal representative of the stroke of said brake pedal;

said signal from said pressure transducer being related to the brake application force applied by a driver to said brake pedal;

a control unit responsive to a demand signal for controlling said brake system actuator, said demand signal being generated as a blended function of both said stroke signal and said signal from said pressure transducer wherein, during an initial movement of said brake pedal, said stroke signal is weighted greater than said signal from said pressure transducer, and wherein, during a subsequent movement of said brake pedal, said signal from said pressure transducer is weighted greater than said stroke signal.

12. The brake system of claim **1** further including a pedal simulator, said pedal simulator comprising:

a housing defining a bore having a first end adapted to be connected in fluid communication with said backup source, said bore further having a second end;

a piston slidably disposed in said bore and having a first face and a second face;

a spring engaging said second face of said piston and acting between said piston and a portion of said housing to urge said first face of said piston toward said first end of said bore; and

a damping circuit hydraulically interposed between said first end of said bore and said backup source to present a first cross sectional flow area to fluid flowing from said backup source through said damping circuit into said housing, and presenting a second cross sectional flow area to fluid flowing from said housing through said damping circuit, the ratio of said second cross sectional flow area to said first cross sectional flow area being greater than unity.

13. The brake system of claim **12** wherein said ratio is less than 10:1.

14. The brake system of claim **13** wherein said ratio is in the range of 2:1 to 4:1.

15. The brake system of claim **12** further including a relief valve opening above a predetermined pressure to permit fluid flow through said relief valve from said brake system to said housing.

16. The brake system of claim **15** wherein said predetermined pressure is in the range of about 5 bar to about 30 bar.

17. The brake system of claim **1** wherein said fluid separator unit has a housing defining a cylinder bore and a piston slideably disposed therein, said piston having a first working face in fluid communication with said normal source and a second working face in fluid communication with said backup source, said first and second working faces having substantially similar areas.

18. A brake system comprising:

a brake pedal for operating a brake system actuator;

a pedal travel sensor for generating a stroke signal representative of the stroke of said brake pedal;

a brake system sensor for generating a force signal representative of the brake application force applied by a driver to said brake pedal;

a control unit responsive to a demand signal for controlling said brake system actuator, said demand signal being generated as a blended function of both said stroke, signal and said force signal wherein, during a first part of the stroke of said brake pedal, said stroke signal is weighted greater than said force signal, and wherein, during a second part of the stoke of said brake pedal, said force signal is weighted greater than said stroke signal.

19. An electro-hydraulic brake system comprising:

a reservoir of hydraulic brake fluid;

a pump having a suction port and a discharge port, said suction port being connected in fluid communication with said reservoir;

a first fluid conduit being connected in fluid communication with said discharge port of said pump;

a fluid separator unit having a housing with a bore defined therethrough, said bore having a first end and a second end, said first end of said bore being connected in fluid communication with said discharge port of said pump via said first fluid conduit, said fluid separator unit further including a piston slidingly disposed in said bore and a spring disposed to urge said piston toward said first end of said bore;

a second fluid conduit connected in fluid communication with said second end of said fluid separator unit;

a vehicle brake connected in fluid communication with said second end of said fluid separator unit via said second fluid conduit;

a third fluid conduit connected in fluid communication with said vehicle brake;

a hydraulic master cylinder connected in fluid communication with said vehicle brake via said third fluid conduit;

an electrically-operated valve disposed in said third fluid conduit, said valve preventing the flow of hydraulic brake fluid between said master cylinder and said vehicle brake when closed, said valve being open to permit the flow of hydraulic brake fluid between said master cylinder and said vehicle brake when said valve is electrically deenergized;

a fourth fluid conduit connected in fluid communication with said master cylinder and said third fluid conduit;

a pedal simulator connected in fluid communication with said master cylinder via said fourth fluid conduit;

an second electrically-operated valve disposed in said fourth fluid conduit, said second valve being closed to prevent the flow of hydraulic brake fluid between said master cylinder and said pedal simulator when said second valve is deenergized, said second valve permitting the flow of hydraulic brake fluid between said master cylinder and said pedal simulator when said second valve is open; and

a damping circuit hydraulically interposed between said master cylinder and said pedal simulator, said damping circuit comprising, in parallel flow paths, an orifice and a check valve such that said damping circuit presents a first cross sectional flow area to fluid flowing from said

master cylinder through said damping circuit into said pedal simulator, and presenting a second cross sectional flow area, different from said first cross sectional flow area, to fluid flowing from said pedal simulator to said master cylinder through said damping circuit.

20. The electro-hydraulic brake system of claim **19** further including a third electrically-operated valve disposed in said first fluid conduit, said third valve preventing fluid communication between said pump and said fluid separator unit when said third valve is closed, said third valve permitting fluid communication between said pump and said fluid separator unit when said third valve is open, the electro-hydraulic brake system further including fifth fluid conduit having a first end connected in fluid communication with said first fluid conduit and said fluid separator unit and having a second connected in fluid communication with said reservoir, the electro-hydraulic brake system further including a fourth electrically-operated valve disposed in said fifth fluid conduit, said fourth valve preventing fluid communication between said fluid separator unit and said reservoir when said fourth valve is closed, said fourth valve permitting fluid communication between said fluid separator unit and said reservoir when said fourth valve is open.

* * * * *

21. A brake system comprising:

an axle of a vehicle;

a first wheel brake mounted on said axle;

a second wheel brake mounted on said axle;

a normal source of pressurized hydraulic brake fluid adapted to selectively supply hydraulic brake fluid to said first wheel brake and said second wheel brake;

a backup source of pressurized hydraulic brake fluid comprising a master cylinder;

a first backup fluid conduit extending between said master cylinder and said first wheel brake to selectively provide fluid communication between said backup source and said first wheel brake; and

a second backup fluid conduit extending between said master cylinder and said second wheel brake to selectively provide fluid communication between said backup source and said second wheel brake.

22. A hydraulic brake system for a vehicle comprising:

wheel brakes for four wheels, in which the wheels are distributed with a first and second wheel brake on a first vehicle axle and a third and a fourth wheel brake on a second vehicle axle;

a normal hydraulic energy source, having electrically controllable brake valve devices disposed between said energy source and said wheel brakes;

a brake pedal;

a first brake system sensor that is actuated by said brake pedal, for carrying out brake operations by operation of the electrically controllable brake valve devices;

a master cylinder supplying two brake circuits, said master cylinder being actuated by said brake pedal and being intended for carrying out a backup brake operation by muscle-powered energy via said brake pedal, each brake circuit being in fluid communication with at least one of said wheel brakes;

a respective normally open isolation valve being disposed between said master cylinder and said wheel brakes in each of said two brake circuits, each of said isolation valves being switched into a closed position when said wheel brakes are supplied with fluid from said normal hydraulic energy source, and wherein at least the electrically controllable brake valve devices are controlled by a control unit; and

a respective fluid separator unit being interposed between each of said first and second wheel brakes of said first vehicle axle and an associated one of the electrically controllable brake valve devices, said first and second wheel brakes being connected to a respective one of said isolation valves associated with said two brake circuits of said master cylinder.

23. A hydraulic brake system for a vehicle comprising:

wheel brakes for two wheels, in which the wheels are distributed at each end of a front vehicle axle;

a normal source of pressurized hydraulic brake fluid, having electrically controllable brake valve devices disposed between said normal source and said wheel brakes;

a brake pedal;

a master cylinder supplying two brake circuits, said master cylinder being actuated by said brake pedal and being intended for carrying out a backup brake operation by muscle-powered energy via said brake pedal, each of said brake circuits being in fluid communication with a respective one of said wheel brakes; and

a respective normally open isolation valve being disposed between said master cylinder and said respective one of said wheel brakes in each brake circuit, each of said isolation valves being electrically switched into a closed position when said wheel brakes are supplied with fluid from said normal source, and wherein at least the electrically controllable brake valve devices are controlled by a control unit in response to a braking demand signal.

24. The hydraulic brake system of Claim 23, said normal source including a motor driven pump for pumping hydraulic brake fluid from a reservoir, wherein said electrically controllable brake valve devices are arranged to block a respective flow path from said normal source to said wheel brakes and to open a respective flow path from said wheel brakes to said reservoir when no braking is being demanded.

25. A hydraulic brake system for a vehicle comprising:

wheel brakes for two wheels, in which the wheels are distributed at each end of a front vehicle axle;

a hydraulic fluid reservoir;

a normal source of pressurized hydraulic brake fluid, having a motor-driven pump for pumping hydraulic brake fluid from said reservoir;

a brake pedal;

a master cylinder supplying two brake circuits, said master cylinder being actuated by said brake pedal and being intended for carrying out a backup brake operation by muscle-powered energy via said brake pedal, each of said brake circuits being in fluid communication with a respective one of said wheel brakes; and

a respective electrically controllable brake valve device associated with each of said wheel brakes, said electrically controllable brake valve devices being arranged to block a respective flow path from said normal source to said wheel brakes and to open a respective flow path from said wheel brakes to said reservoir when no braking is being demanded.